

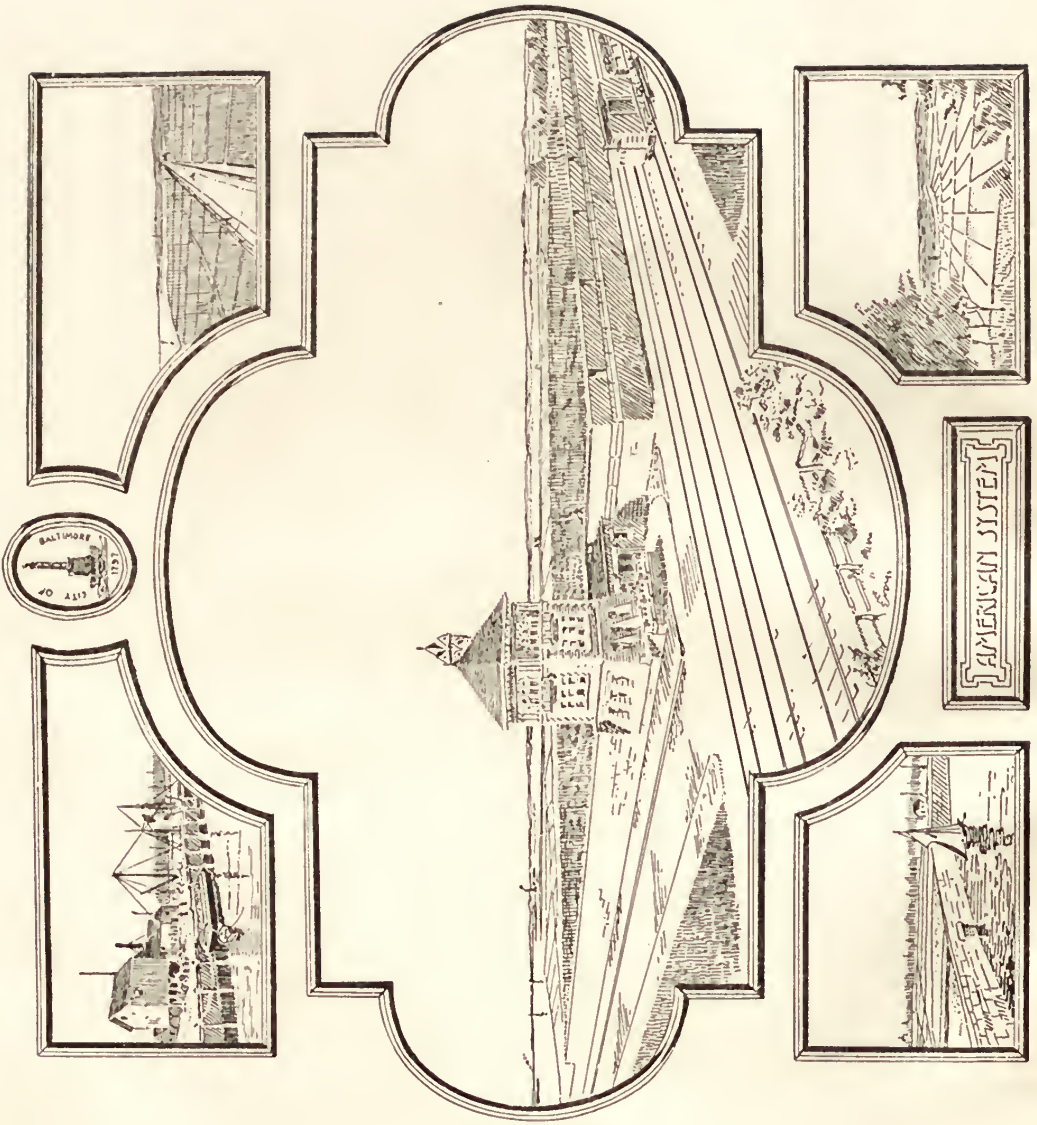
REPORT  
TO THE  
MAYOR OF BALTIMORE  
ON THE  
AMERICAN SYSTEM  
OF SEWAGE DISPOSAL

MADE BY  
✓  
JOHN N. McCLINTOCK, A.M., C.E.  
PRESIDENT AND GENERAL MANAGER  
AMERICAN SEWAGE DISPOSAL COMPANY OF BOSTON



62829  
Registration fund  
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BOSTON  
WRIGHT AND POTTER PRINTING COMPANY  
18 POST OFFICE SQUARE  
1903



AMERICAN SYSTEM

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MADE BY

JOHN N. McCLINTOCK, A.M., C.E.

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~~Reclamation fund.~~  
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REPORT  
TO THE  
MAYOR OF BALTIMORE,

ON THE AMERICAN SYSTEM OF SEWAGE DISPOSAL, MADE BY JOHN N. MCCLINTOCK,  
PRESIDENT AND GENERAL MANAGER, AMERICAN SEWAGE DISPOSAL COMPANY  
OF BOSTON, 1903.

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*To His Honor the Mayor of Baltimore.*

SIR:—I have the honor to submit for your consideration a report and accompanying plans as to the adaptability to the needs of Baltimore of the American System of Sewage Disposal, based upon the elaborate topographical survey of the city and the reports of the sewerage commission published in 1897 and 1899.

The American System of Sewage Disposal (invented by an American), embracing septic-action filter-beds retaining the sewage for liquefaction, provision for the gases resulting therefrom and secondary filter-beds, makes it possible for Baltimore to inoffensively purify the sewage of the city within its own territory, and to discharge such an effluent into the harbor as cannot injure the fishing or oyster industry, or leave any deposit in the harbor.

In considering its adoption, various problems arise.

The first problem is whether the surface drains are to be used to carry sewage, or whether sewage is to be carried by a new and entirely distinct system, not receiving ground water or surface drainage. The engineers who have advised the city favor the separate system, and it is the safest on many accounts.

The second problem is to determine what proportion of all the water, both rainfall and water supply, reaching the city will reach the disposal works in the form of sewage, assuming the use of the separate system, and a present water supply through

the mains of 50,000,000 gallons per day, slowly but surely increasing with the growth of the city and the improvement of conditions afforded by the sewerage system.

While the water supply of the city amounts to about 100 gallons per capita per day, the rainfall in the thickly settled section, if it were evenly distributed throughout the year, would amount to 40 gallons per capita per day, making a total of 140 gallons per capita per day to care for. When the new separate sewerage system is built, to receive only sewage, Baltimore will still have very generally covering the city the surface drainage system, which should receive all the rain water, all the ground water, all the water used in street sprinkling, on the lawn, in the garden, from hydrant and sill-cock, the overflow from watering troughs and public drinking fountains, the waste water from motor, elevator and from other sources, and all unpolluted water.

My estimate, under the above-named conditions, is that less than three-fourths of the water supply arriving through the mains need ever reach the sewage sewers of the separate system; that, therefore, with the present water supply of 50,000,000 gallons, provision need be made for only 36,000,000 gallons of sewage daily; and an average of 60 gallons of sewage per capita for the total number of inhabitants of the districts served by the separate sewerage system is an ample allowance and may never be exceeded. And, should the city not adopt the policy above referred to, but permit the entire 100 gallons per capita per day to reach the sewage sewers, since the organic pollution is not thereby increased, the size of the disposal plant probably need be increased little if any on this account.

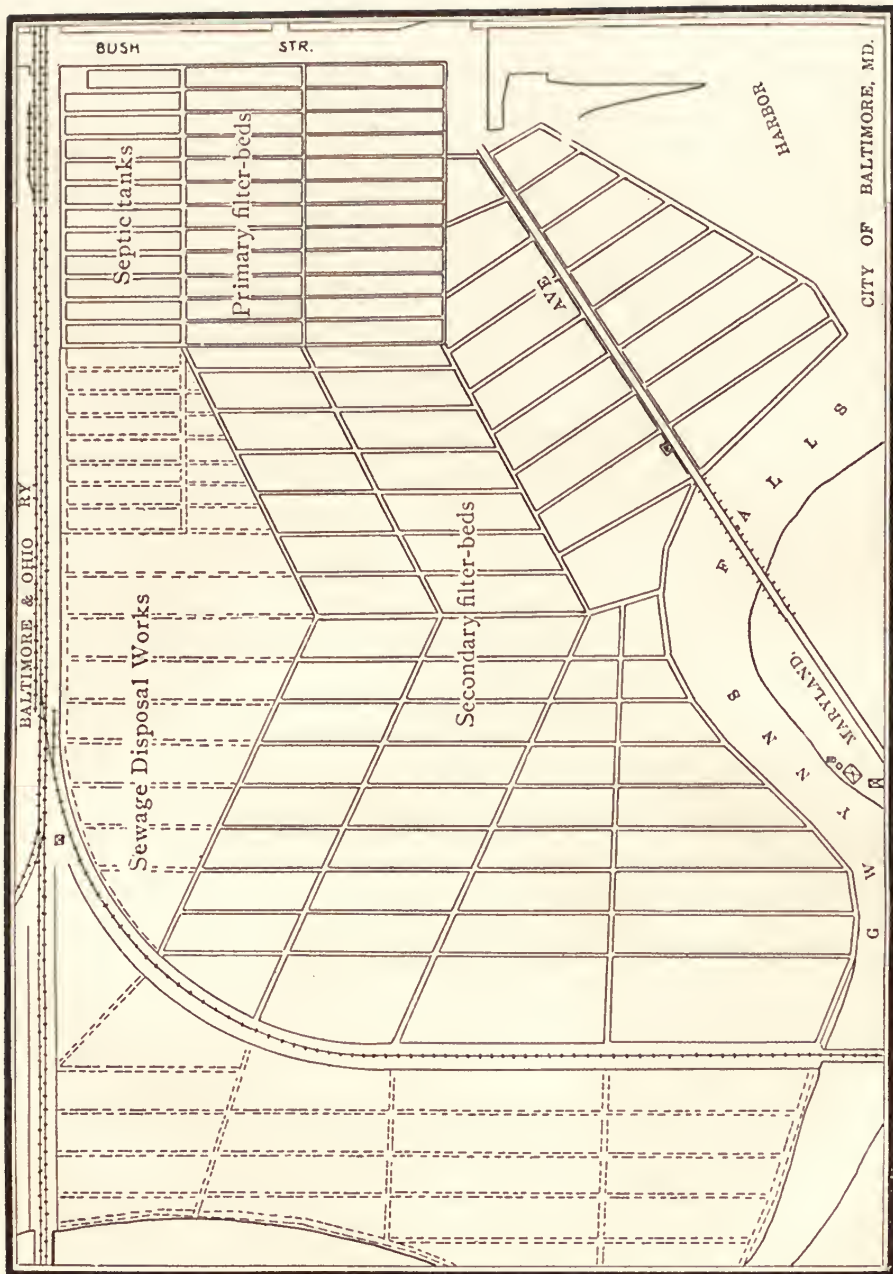
The third problem to be settled is the location of the sewage disposal works. This problem involves the cost of the land to be utilized for disposal purposes, the character of adjacent property, the expense of bringing the sewage to the works and the disposal of the purified effluent.



It is possible by the American System to inoffensively purify the sewage of Baltimore in Druid Hill Park; but the expense of raising it to the proper elevation would be like that involved by carrying it to Glen Bournie, in Anne Arundel County. As it is desirable to locate the sewage disposal works within the jurisdiction of the city, and at as low an elevation as possible, in order to save expense of carriage and pumping, a study of the topography of the city suggests a tract of land bounded by Bush Street, the land of the Baltimore & Ohio Railroad, Gwynn's Falls and the harbor, comprising about 90 acres, as available for the purification of sewage by the American System. The survey indicates that a large part of this territory is marsh, and on account of its character must have a low value; there is more land in the neighborhood that may be secured for the extension of the works in the future; Gwynn's Falls, a stream of fresh water, is available to receive the effluent near the harbor; and the topography of the city permits the sewage to be delivered by gravity at this territory at a sufficient elevation to be treated from all sections, save the low-lying districts near the docks, the sewage from which section will have to be pumped in any event in order to be treated.

The fourth problem to be settled by the city is the system of sewage disposal to be adopted. There are four systems only that can be considered.

*Dilution*, or discharging sewage untreated into the salt water of the harbor, at the point selected, is too manifestly objectionable to be even discussed; while dilution in the waters of Chesapeake Bay will cost at first, according to the 1899 report of the sewerage commission, \$3,202,846 to care for a population of 220,000, and \$198,172 yearly to maintain; and, with the sewers, for a population of 1,000,000 \$10,153,331 to build, and \$361,461 yearly to maintain; which funded at 4 per cent. means an increase in cost of \$9,036,525, or a total cost of \$19,189,856, or a per capita cost of \$19.19.



This system is objectionable for its cost, and because it injures the fish and oyster industry. Sewage consumes the oxygen in the water upon which the fish depend; fish confined in sewage-polluted water die; sewage discharged into a river drives away the game fish and poisons the oyster.

It is contrary to United States Statutes, enacted March 3, 1899, section 13, of the river and harbor bill, to discharge sewage save in a liquid form into any navigable water of the United States or into any tributary thereof. If the solid matter is taken from the sewage, it is absurd to carry the liquid so far; if the offensive matter in the sewage can be taken out inoffensively, there is no need to carry the sewage further than where it can be collected in one place for such treatment.

*Chemical precipitation* might be employed at the locality suggested but would not be satisfactory, because it would involve a large annual expense for chemicals and attendance; because it necessitates the care, removal and disposal of vast quantities of sludge of very little commercial value; and also because the effluent from the system would carry much pollution to the harbor. It has not been recommended by the sewerage commission or the consulting engineers, and need be no further discussed.

*Intermittent filtration*, broad irrigation or sewage farming is undoubtedly the best system of the three known to and considered by the sewerage commission and their expert advisers in 1897 to be adopted by the city of Baltimore, but it involves such a vast expense for machinery, pipe lines, land and maintenance, to make available such a small manurial value in the sewage, that it does not appeal to the judgment of the thoughtful taxpayer. The cost of this system with sewers is estimated by the sewerage commission in their 1899 report to be, when completed, for a population of 1,000,000, \$14,440,241; the annual cost of maintenance, \$781,683, representing at 4 per cent. an



additional cost of \$19,542,750; or a total cost of \$33,982,991, or a per capita tax of \$33.98; the number of acres enriched by the sewage, 5,384; and the income from the sale of crops, \$10,768; or merely enough to pay the interest on the cost of the land and the taxes.

*The American System* (invented by Amasa S. Glover) makes it possible to purify 50,000,000 gallons of sewage a day on 50 acres of land, and obtain as satisfactory an effluent as from 2,000 acres by intermittent filtration, or from 6,000 acres by sewage farming.

In a word it is this: a receptacle for the sewage in which the solid matters are liquefied and resolved into constituents, a part of which escapes in the form of volatile but very offensive gases, leaving a small amount of residuum, partly mineral, in the bottom of the receptacle; an enclosing structure with provision for said gases; secondary open-air filters upon which the liquid effluent flows from said first receptacle through such material, or means of discharge, as to hold back the solid matter and emit only the liquefied and partially purified effluent, whose purification is then completed by a process of oxidation and nitrification on said open-air filters.

The system is very simple, as illustrated by a description of the South Sewage Disposal Works, a plan of which I herewith submit and recommend for the location south of Bush Street and east of the Baltimore & Ohio Railroad. It consists of a primary filter-bed of any suitable construction and proportion, holding 1,536,000 gallons, or twelve hours' flow, roofed over and ventilated to dispose of the gases arising from the conversion of the solids into their constituent parts, and receiving the sewage by gravity or by pumping, through which tank the flow is continuous, at the rate of 3,072,000 gallons per twenty-four hours, and so constructed as to retain the solid sewage matter until liquefied and then permit the liquid to escape on to filtering



material. This filtering material is shown as of half the capacity of the septic tank, and of the size of road metal. The flow of the liquid effluent through this filtering material is continuous; but it is so planned, in this instance, that it may act as an intermittent filter at the will of the superintendent. This is followed by about one-half as much more filtering material of a much finer character, through which the liquid effluent flows continuously, if desired, or intermittently. This whole structure is roofed over, and a chimney receives the offensive gases which are liberated by the bacterio-chemical action. These gases, as Mr. Glover suggested, may be easily burned, if desired, and their heat utilized. In any event their volatile character insures their dispersion through the chimney with absolutely *no* offence to the health or nostrils.

Thence the effluent, from which, by sedimentation, chemico-bacterial disintegration and liquefaction, the solids have been largely removed, is received into a channel, extending between a series of open-air secondary filter-beds, having gates permitting it to flow upon the surface of said open-air beds intermittently, and further means to draw the water from these secondary filter-beds into a discharge pipe leading to Gwynn's Falls.

The operation of the system in working order is as follows: the primary filter-bed, holding 1,536,000 gallons of septic sewage, will receive and care for 3,072,000 gallons of fresh sewage in twenty-four hours as its normal work; or it may receive 6,000,000 gallons of sewage occasionally in twenty-four hours without injury to the system. The sewage flows continuously through it; and being in a state of comparative rest in the tank clarifies itself of the heavier matters by their sedimentation, disintegration and liquefactions, and of some of the fatty matter by floating. The bacterio-chemical process known as "septic action" thus continuously liquefies the solids and disintegrates the dissolved organic matter. Only about 5 per cent. of the suspended matter escapes.

as such, the remainder having been changed to a gaseous or a soluble condition; only about 15 per cent. of the bacteria escapes. The greater part of the suspended matter that escapes is nitrogenous, while the carbonaceous matter that clogs the ordinary filter is retained or liquefied. "Septic action" — in other words rot — is largely brought about here by the so-called anaerobic bacteria. The bacteria that give life to an out-of-door filter and make it operative are chiefly the aerobic or nitrifying bacteria.

Septic action may or may not be continued while the sewage passes through the first filtering material, according to the amount of previous septic action in relation to the amount of sewage.

The second and finer filtering material will be used as a contact bacteria bed, acting upon the effluent from the first filtering material by a class of aerobic bacteria that assimilates the organic matter brought in contact with them, thus largely eliminating it from the effluent. These two classes of filtering materials later on, perhaps, may be unified. The additional function for which they are here designed is to *insure* the prevention of the escape of any suspended matters on to the out-of-door secondary filter-beds which might clog them. Incidentally, this would also help to insure an effluent which could not injure fish or oysters. From the apparatus so far described escapes a clear and nearly odorless effluent.

A series of 12 such primary filter-beds, as is shown by the plan, would hold about 18,432,000 gallons, and would afford the proper septic action for a daily flow of 36,000,000 gallons, as previously herein estimated, or all the sewage from the present population of the city.

Finally, the 40 acres of open-air secondary filter-beds will sufficiently purify the 36,000,000 gallons of the daily effluent of the primary filter-beds, and will have the capacity to purify a much greater amount.



To summarize the proposed process of disposing of the Baltimore sewage: it takes the crude sewage and divests it by "septic action," as the bacterio-chemical changes are named, of all offensive matter, and very largely of all impurities; and then, by nitrification and oxidation, completes the purification; so that what enters the works as sewage is therein converted back into its harmless elements; and what comes out of the works as an effluent is merely harmless water, — as harmless as the natural water of the harbor into which it would be discharged.

The American System of Sewage Disposal for the present population of the city can be constructed upon 50 acres of available land, which, when enlarged upon 100 acres available, will purify the sewage from a population of 1,000,000. It can be so operated as not to give offence in the immediate neighborhood or elsewhere. It can be completed in a permanent and substantial manner for \$1,500,000 for the present population, and enlarged pro rata. It can be made automatic in a large part of its operation, and so not be wholly dependent upon careless attendants. It will create no appreciable amount of refuse sludge to care for. It can be operated for many years without clogging the filters of the system. We confidently ask your city to adopt this system, not necessarily in the location that I have selected, or built in the precise form that I suggest, but *somewhere* and *somehow*, as the best engineering skill you may find available shall determine.

The fifth problem is a question of details. As the solution of this problem depends largely upon a settlement of the foregoing problems, I will assume that for a number of years the sewage reaching the South Sewage Disposal Works, located at the point suggested near Bush Street, is collected by the separate sewerage system, amounts to 60 gallons per capita per day for the population served by the system, and that the American System of Sewage Disposal is adopted. The details of one unit

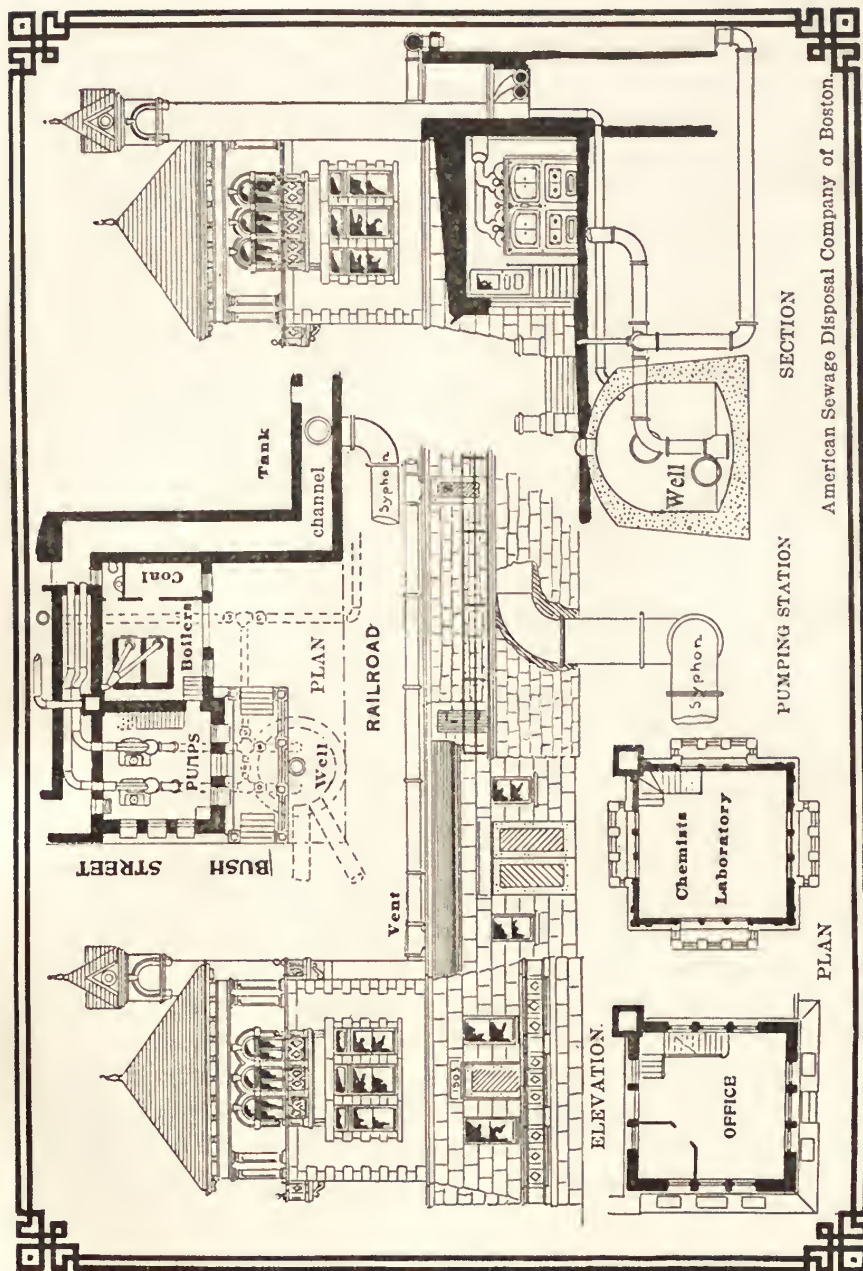


of this system may be as follows: a primary filter-bed, retaining the sewage for septic action, roofed over and ventilated, of masonry, concrete, iron, steel, expanded metal and concrete, or of any suitable construction, may be built, with its watertight bottom at grade 0.0, or low water, holding 1,536,000 gallons; filtering material in the form of a continuous contact bed, filled with broken stone, clinkers or any suitable material, the bottom of the filter at grade 10; additional filtering material in the form of a contact bacteria bed, with bottom at grade 9, filled with proper material; a siphon or other discharge, and a series of perhaps six out-of-door secondary filters, averaging in size one-half acre each, arranged on each side of the supply and outlet channel, filled with filtering material from which the dust and fine matter have been removed by screening, with their bottoms at grade 1.0 or higher. This apparatus would normally purify 3,000,000 gallons of sewage per day, as hereinbefore explained.

A 5-foot iron pipe (or, if preferred, two of equal capacity) laid in the form of an inverted siphon, extending from the primary filter to a point on Liberty and Howard streets at sewer grade 32, branching where necessary into pipes of reduced size, and leading to points in the different water-sheds of the city, presumably where the sewer grade is 35 or higher, could provide a current that would deliver all sewage to the primary filter from the higher levels of the city for many years.

After the construction of the first unit of the system, as aforesaid, and the laying of the inverted siphon and the construction of the district and lateral sewers, the proposed system is ready for use to the extent of this unit, and may be completed by adding the necessary number of units as fast or as slowly as desired.

Upon completion of the first unit, as above described, work should be commenced at once on a second unit; when that is completed, the third can be built; and so on, as needed.



American Sewage Disposal Company of Boston.

I have had designed a small power house, pumping station, office, laboratory and a ventilator for the primary filter-beds, combined in one structure. Here the small amount of sewage of the neighborhood, and all that can be brought by gravity which cannot enter the inverted siphon, may be pumped into the primary filter.

The sewage of the central district, that now drains into Jones Falls near North Avenue, may be purified at what is shown on the plans as the Central Sewage Disposal Works, or, as the sewage can be collected at grade 60, it is possible to carry it by gravity through an iron main built as an inverted siphon to one of the arms of the 5-foot inverted siphon, and thence flow to the South Sewage Disposal Works.

The sewage of the eastern section of the city above a certain grade can be delivered in a similar manner.

The sewage of the city along the harbor front can be collected by an intercepting sewer and carried to some point where might be built a pumping station to force the sewage of the east district to the South Sewage Disposal Works.

The sixth problem involved is the cost of the construction of the disposal works and the sewerage system connected therewith. In view of the fact that the lateral sewers have all to be built in any event, and that a number of years must elapse before they can be built, and that it is not necessary to build disposal works faster than they are required, it may be well to build two units of the disposal works, as above described, the first year, to provide for 100,000 of the population; and two units every following year, providing for 100,000 more of the inhabitants, until the city is wholly provided for.

Without definite knowledge as to the cost of the land and the price of labor and material in Baltimore, I estimate generally that each unit of the system can be built for \$125,000; that twelve such units, caring for 600,000 people, can be built for

\$1,500,000 in six years; that twenty such units, caring for 1,000,000, can be built for \$2,500,000.

The cost of the district and lateral sewers has been estimated by the sewerage commission to be \$2,032,500 for the present, and eventually \$5,280,000.

The cost of the inverted siphon and intercepting sewers and force mains may be \$1,500,000.

The cost of the pumping station at the disposal works, with the necessary machinery, may be \$50,000.

The cost of the pumping station and machinery at the east district may be \$100,000.

To summarize the above items, the cost of the American System of Sewage Disposal and the required sewers may be as follows:—

For the present population of 600,000:—

|                                                         |             |
|---------------------------------------------------------|-------------|
| Twelve units of American System, at \$125,000 each,     | \$1,500,000 |
| Siphons, force mains and intercepting sewers, . . . . . | 1,500,000   |
| District and lateral sewers, . . . . .                  | 2,033,500   |
| Pumping stations, . . . . .                             | 150,000     |
| Yearly maintenance up to 1,000,000 population,          |             |
| \$50,000 funded at 4 per cent., . . . . .               | 1,250,000   |

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|                              |             |
|------------------------------|-------------|
| Total for 600,000, . . . . . | \$6,433,500 |
|------------------------------|-------------|

For future population of 1,000,000 add:—

|                                                              |           |
|--------------------------------------------------------------|-----------|
| Eight units of American System, at \$125,000 each, . . . . . | 1,000,000 |
| District and lateral sewers, . . . . .                       | 3,246,500 |

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|                                |              |
|--------------------------------|--------------|
| Total for 1,000,000, . . . . . | \$10,680,000 |
|--------------------------------|--------------|

The seventh problem to settle definitely is whether the city will adopt the American System of Sewage Disposal.

The same system upon which the American Sewage Disposal Company of Boston holds the United States patents is in



successful operation in disposing of all or a part of the sewage of some of the largest English cities, — London, Manchester, Birmingham, Leeds and Exeter, — and is in use in several American cities.

This system, as such, has been approved by such eminent scientists and sanitarians as Mr. Fowler of Manchester and Dr. Rideal of London, State Chemist Clark, Professor Sedgwick and Professor Kinnicutt of Massachusetts, Professor Folwell of Pennsylvania, and Professor Talbot of Illinois.

This system is recognized as sound practice by such leading technical publications as the "Engineering News," "The Engineering Record" and the "Engineering Magazine," and by many medical journals.

The introduction of the system has been effected under the direction of leading civil and sanitary engineers in the places above referred to.

In short, *dilution* of the sewage by discharging it into Chesapeake Bay, aside from being dangerous and offensive, has been estimated by the sewerage commission to cost the city of Baltimore \$10,153,331 to construct and \$361,461 yearly to maintain; or a per capita tax of \$19.19; and

*Chemical precipitation* has no friends or advocates; and

*Sewage farming*, or broad irrigation, has been estimated by the sewerage commission to cost \$14,440,241 to construct and \$781,688 annually to maintain; or a per capita tax of \$33.98; and

The *American System*, demonstrated to be effective and inoffensive, can be built to care for the sewage of the present population of the city, including the sewers and appurtenances, for \$5,183,500; and to care for the sewage of a population of 1,000,000 for \$9,430,000; can be maintained for \$50,000 per year, or a per capita tax of \$10.68.

We ask you to accept the American System, which in no essential respect conflicts with the reports of the Baltimore sew-



erage commission, although it submits a better system and one which has been successfully tested since the date of the reports. At that time the advice therein given would have been generally regarded as the best that could have been offered, and the best even to-day if that report be so modified as to take cognizance of the wide and increasing adoption of the so-called "septic tank" system, which we consider to be the subject-matter of our patent rights. But the recent and rapid adoption of this system at home and in England is sufficient evidence that it possesses extraordinary advantages over any system previously used. Some of the claims which constitute our argument for the use of the American System are as follows (and in making the comparison we accept the cost of other systems as estimated by the sewerage commission and also this commission's estimate of the quantity of sewage to be provided for, which, however, as already explained, we think unnecessarily large): —

It occupies a smaller area than essential in irrigation or intermittent filtration, and so admits of a much greater choice of locality for purification.

The works are perfectly inoffensive, which cannot be said of the outlet of a sewer, or of the deposits caused by dilution for miles along the shore, or of a sewage farm.

It delivers to the river and bay a liquid comparatively pure and free from all objectionable bacteria, which neither dilution or chemical precipitation can possibly accomplish.

In consequence, it affords absolute protection to the oyster industry, and, furthermore, removes any possibility that bay oysters can spread typhoid fever germs received from the sewage.

It costs less to maintain than any of the other systems.

The first cost of a complete plant under the American System would be less than that of irrigation or intermittent filtration; and probably less, at least not more, than dilution in the harbor, which must be left out of the question; and certainly much less than dilution in the bay.

Immediate benefit may be obtained for a first expenditure of \$1,000,000 (providing liberally for the essential siphons, force mains and sewers) and for each \$125,000 additional; whereas, if dilution be adopted, no advantage could accrue from it until \$3,800,000 had been spent upon the outfall and appurtenances; and if filtration be adopted, until approximately \$3,000,000 had been spent.

The American Sewage Disposal Company of Boston ask a royalty under their patents of 10 per cent. of the cost of the disposal works as fast as built and 1 per cent. of that cost for every year for ten years. This includes the plans and report herewith submitted, and consultation, if desired, with our experts.

This royalty has been included in the estimate of the total cost of the disposal works hereinbefore made.

Very respectfully submitted by

JOHN N. McCLINTOCK,

*President and General Manager, American  
Sewage Disposal Company of Boston.*

## LETTER.

*To His Honor the Mayor of Baltimore.*

DEAR SIR:—In connection with the American Sewage Disposal Company report, I would like to personally call your attention to certain facts, advice and deductions that may be of interest.

### CHESAPEAKE BAY AND ITS OYSTERS.

Oysters thrive best in an arm of the sea which receives a certain amount of fresh water; too much water, like a freshet, will often kill them; too little water will stunt them.

Chesapeake Bay is most favorably situated for their growth and cultivation on account of its depth, of the climate and of the body of fresh water supplied by the Susquehanna and other rivers. Science may not yet have demonstrated how the oxygen in the water is necessary for the existence of the fish, or how fresh water mixed with salt water is essential to the oyster, but both facts, if not of common knowledge, are well known to oystermen and fishermen. While the physicians are now protesting against making the oyster a medium for transmitting disease, I cannot advise the pollution of the fresh water that gives life to the oysters of Chesapeake Bay, by the sewage of Baltimore, laden with all manner of germs of putrefaction and frequently disease. What was permitted in the last century is repudiated to-day in the light of recent investigation.

There is no body of water in any part of the world where the conditions for the cultivation of the oyster are so favorable as in Chesapeake Bay; but these conditions may change.

Let me give you a reminiscence: In Isle au Breton Sound in 1870 there was not a tree in sight from the marsh shore; yet in certain creeks the utmost care had to be used while doing coast survey work to keep the boat from snagging on the stumps of a submerged cedar forest. These stumps would

quickly disappear by the action of marine life in salt water; but the fresh water from the Mississippi River, coming into these creeks through irrigation channels, killed what usually destroyed wood and preserved the stumps, perhaps for ages. On these submerged stumps there grew oysters, known in the New Orleans market as Cedar Bayou oysters, which were worth then \$8 a barrel, while the common oysters brought \$1.50. A ready sale was found for all that were offered. I have had those oysters opened in the creek and have eaten them fresh from the water when I had to cut the oyster into four parts to eat it raw; one would fill a saucer. The shells of some were nine inches long. Those oysters were dainty and delicious food and never to be forgotten; they recalled rich cream from clover-fed Jersey cattle, gilt-edged butter, and all sorts of nice things, and were as rich and as nice to eat as anything in the world. I was told then that no oysters compared with the Cedar Bayou oysters for size and delicacy except the Chesapeake Bay oyster, and in later years I confirmed the statement by personal observation.

The growth and delicacy of the Cedar Bayou oyster convinced me that oysters thrive best where they receive a considerable quantity of fresh water. I am unable to explain why oysters thrive best under the conditions offered in those Louisiana cedar bayous and in Chesapeake Bay, and grow to a phenomenal size and to great perfection as an article of food there, and very seldom elsewhere. I am led to ascribe the results to similar causes. If oysters are affected by fresh water it is reasonable to believe that if the water offered to them is polluted by sewage, the oyster will become polluted.

The sewage of Baltimore, discharged at the head of the bay where the fresh water of the Susquehanna enters it, would, in my opinion, have a tendency to pollute the oysters the whole length of the bay. It would be much better for the oyster to keep the sewage of the city (if it *must* enter tide-water) in the

tidal estuary of the Patapsco River, or in the harbor itself, than to discharge it into the bay.

Chesapeake Bay has an area of 2,500 square miles. It receives a dry-weather flow from the Susquehanna River of 41,000 cubic feet per second of fresh water. From a water-shed of 71,000 square miles the bay receives an average flow of 132,000 cubic feet per second of fresh water. During a year the fresh water from the Susquehanna at the rate of the dry-weather flow would amount to a depth of 18.48 feet over the entire bay, while the estimated amount from the whole water-shed during the same time would cover the salt water to a depth of 59.55 feet.

This addition of fresh water to the bay did not commence, however, with the year, but away back in the times when the glaciers began to disappear.

As there is only about sixteen inches of tide at the head of the bay, the ocean cannot intrude between the capes much fresh salt water, so to speak; and the result is the magnificent conditions for cultivating the oyster in Chesapeake Bay.

The tendency of fresh water is to float on the top of salt water. Fresh water will gradually force salt water down and out of sand to a great depth. If a sand bar were formed across the mouth of the bay above high water it would be only a question of time before the salt water was entirely crowded out of the bay, and it became Chesapeake Lake. It is a problem what becomes of the enormous quantity of fresh water that annually enters the bay. There is no gulf stream of fresh water running down the bay, so the inference is that it mingles with the salt water and greatly dilutes it.

That the towns and cities upon the Susquehanna River are polluting the water with their sewage is no reason or excuse for Baltimore polluting the bay. A great river has a tendency to purify itself by natural laws. Purification is hastened in fresh water and retarded in salt water. In time Pennsylvania will be



called upon to remove sewage from every brook and river in the State; and at some time the national government will strictly enforce the laws already enacted against pollution of rivers and harbors.

Dr. Sims Woodhead found, according to the sewerage commission, that crude sewage containing about a half million organisms per cubic centimeter, when inoculated into the filtered effluent of the septic tank (or water similar to that brought by the Susquehanna River to Chesapeake Bay) developed more than one thousand millions in five days.

It seems to me, therefore, that Baltimore must give up the scheme of an outfall sewer to the bay or the use of the bay oysters as a safe article of food.

#### THE CAPACITY OF SYSTEM.

The American System of Sewage Disposal is elastic in its functions, because, while the primary filter-beds, as described in the report, are best adapted to purify or filter 36,000,000 gallons of sewage in twenty-four hours, they will operate just as favorably if they receive a smaller amount; and, on the other hand, they will do good work if they receive a larger amount. Within proper limits, and with proper management, it seems that the American System is perpetual, — it cannot "wear out."

The secondary out-of-door filter-beds, adapted to purify 36,000,000 gallons of the effluent of the primary filter-beds, may be taxed for a considerably greater amount per acre per day if a proper effluent from the primary filter-beds.

If crude sewage, *i. e.*, not purified in the primary filters, were to be applied to the secondary filter-beds of 40 acres at the rate of 1,000,000 gallons a day, or 25,000 gallons per acre per day, the beds would only operate a few years before becoming clogged and useless, as has been demonstrated at Plainfield, N. J., and elsewhere.

## THE CONSTRUCTION

of the sewage-purifying apparatus might well be entrusted by the city to men specially appointed, who have the necessary knowledge, who can be trusted, and who may reasonably expect retention in office. A superintendent should be a good executive, with ability and education enough to permit him to understand the operation of the various parts of this system, with faith in the system gained by investigation, and should command a salary upon which he can live with dignity. He will become the dean of Superintendents of Scientific Sewage Disposal Works in America, and rank in this country as do Mr. Fowler of Manchester and Dr. Rideal of London in Great Britain. A chemist is another important officer of the works.

It may be that ashes can be used in the construction. The fine ash obtained by sifting may be the proper material to form the foundation of the filters on the marsh, while the coal and clinkers may be found to withstand the action of water and bacteria in the filters; and the city, while disposing of its wastes in this manner, will effect a large saving in the cost of construction.

Granite and field stone can be used to face the walls of the septic tanks. There are certain kinds of rock that will not withstand septic action or the action of water, but will disintegrate and consolidate into strata; these must be avoided.

## OPERATION.

In operation the American System may be compared with a thing of life, and must be so fed; for it is life action that produces the results sought. The septic tank of the system is the stomach, that digests all organic matter brought to it by the sewers, and it must not be overworked. The filters may be likened to the lungs; and the alternate filling and discharging to respiration; for it produces a like effect of purifying the vital fluid of the system.

Although it takes a number of days or weeks for a septic tank or filter to become fully effective in its functions, it continues its action with slight attention.

The works are so designed that any tank or filter may be shut off from service for repairs without interfering with the operation of the system as a whole. Provision is not made for permitting the septic tank to be discharged directly into the harbor under any conditions. I have designed a pipe connection that will permit the contents of any tank that has been shut out of use to be pumped into the others of the series.

If for any reason it becomes necessary to shut off the flow of the septic sewage from the first filter, a pipe and gate are provided to permit the filter to be discharged through the underdrains of the second filter upon the surface of one of the secondary filters, that may be used as a so-called sludge filter. Each of the second filters can be thrown out of service.

By using more complicated and expensive construction than shown in the plans it would be possible, without an increase in the area utilized, to increase the efficiency of the Disposal Works to care for a population of 2,000,000 or more.

When the inverted siphon runs full it will be possible to avail of the power created. There is also a source of power, heat and light in the gas generated in the septic tank.

#### MANURIAL VALUE.

According to investigating chemists there is a value in sewage of from \$2 to \$5 per capita per year; so Baltimore will send to the Disposal Works by a completed sewerage system values to the amount of over \$2,000,000 per year. This value is carried by an enormous quantity of water, from which it must be separated to become available.

Some time in the future some investigator may discover how to separate the dissolved organic matter in the sewage from

the water, and recover it for commercial purposes at a profit, but the art is unknown to me.

With the suspended matter in the sewage the case is somewhat different. The sewerage system of Baltimore will carry to the Disposal Works annually more than 100,000 cubic yards of solid organic matter which may be disintegrated there. Perhaps one-half of the value of the sewage is in the suspended matter, that can be either burned up or in part recovered in the processes of the American System. The problem is the economical application to the land. Supposing its value to be \$5 per ton, it certainly will not pay to carry 1,000 tons of water in which the ton is suspended any considerable distance; taken from the water, it is a question how far it would pay to transport the ton. If there should be a demand for it when the works are completed, the sewage may be all passed through one tank before reaching the others, with the result that septic action will be arrested, and the solid matters will accumulate until the tank is full; and the sludge may be pumped into oil tank cars, or into tanks on vessels, or through a 6-inch iron force main to Anne Arundel County, so that it can be shipped to a market when a market can be found for it. It becomes good fertilizing material in the course of from eighteen months to two years.

Sewage farming in America is poor economy unless in some arid region where the water is needed for irrigation.

### SEWERS.

It is not necessary for me to advise Baltimore as to the size and grade and manner of construction of the sewers, outside of the Disposal Works. I beg to suggest that the sewers should be laid with water-tight joints, so that ground water may be excluded, and that where necessary underdrains be laid in connection with the sewers, to care for ground water, and to discharge into the surface drains or wherever practical. Such construc-

tion will greatly reduce the size of pipes required and lessen the expense of pumping.

It has been assumed that the surface drains of Baltimore receive no sewage directly but are restricted to rain water. It may be possible to admit the dry-weather flow of the surface drains to the new system by providing storm overflows through existing channels to the harbor, for the relief of certain districts, until some time in the future, when the lateral sewers are laid.

If what the surface drains carry at present does not cause offence, there can be no objection to this proceeding. It may be possible that in the past some sewage has found a way into the surface drains, so that the discharge needs purification; if so, it might be well to build the intercepting sewers to tap the surface drains for the dry-weather flow at as early a date as practicable.

#### CONNECTIONS.

Primarily the new system is to remove organic matter, and is especially adapted to dispose of domestic sewage. It is also adapted to care for the offensive organic wastes from most manufacturing works.

There are certain wastes, however, chiefly of inorganic matter, that should not be admitted in large quantities to sewers connecting with the American System of Sewage Disposal, as their chemical effects are to retard biological action in the primary or secondary filters, or cause the precipitation and collection in the system of suspended matter. Such substances as lime, copperas, sulphurets, acids and metallic salts interfere with the proper action of the system.

Wherever, within the district drained by the sewerage system, it becomes necessary to dispose of inorganic waste matter from manufacturing establishments which would interfere with biological action, special provision for purification or neutralization may be made, either by the parties interested or by the city.



## MEDICAL ASPECT.

Within recent years science has demonstrated that bacteria are the causes as well as the results of diseases. The great work started by Pasteur, continued by Koch and other scientists, of separating, cultivating and studying the various bacteria that cause specific diseases, with a view of eliminating them, has proven that many of them that are dangerous to the human race survive under conditions afforded by sewage. These include the bacteria of water-borne diseases.

When sewage, without purifying treatment, is discharged directly into either fresh or salt water, there must always be an element of doubt as to the ultimate mission of the disease germs that are thus scattered.

The American System of Sewage Disposal not only permits a sewerage system to be safely built in any city, but renders it advisable to have it built, for the reason that all manner of disease germs may be properly consigned to the sewers connecting with the system.

It is a well-established fact that disease germs do not originate, but are propagated from some antecedent case; therefore, to eliminate such diseases from a community, the germs from the known cases need to be destroyed.

Dr. Pickard\* specially investigated the typhoid microbe. He concluded that the sewage itself was not only a bad food, but an actual poison to these bacteria; that in the septic tank they suffered a rapid destruction, and that the filter-beds effect a further biological elimination, so that there is no chance whatever of the filtered effluent causing typhoid fever if it passed into the river.

Respectfully submitted,

JOHN N. McCLINTOCK.

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\* Second report of Sewerage Commission, page 13.